COLLEGE OF SURGEONS OF ENGLAND
30 OCT 30
LIBRARY
1883
Tracts B.
174 (1)

THE CHOLERA AND OUR WATER-SUPPLY.

The interest which has been awakened in the sanitary bearing of water-supply is largely due to the development of the germ-theory of disease. According to this theory several, at least, of those diseases which are propagated in the manner of epidemics diffuse themselves by living germs or spores, which, finding a suitable nidus in the bodies of animals, there multiply and produce that specific disturbance of the normal functions which characterises a disease of the zymotic class. It is, in fact, believed by the advocates of this theory that those diseases which are known by the name 'zymotic' are the result of the development and growth within the body of the affected individual of minute organisms akin to those which are known to induce fermentation, and the vitality of which is taken advantage of in brewing and other allied industries.

Although the germ-theory of disease is still *only* a theory, yet it is supported by the evidence of such numerous facts and observations as to be almost irresistible. Moreover, recent pathological research tends to show that other diseases, such as phthisis, which have not hitherto been regarded as belonging to the zymotic class, are very possibly communicated by minute living organisms of the same kind.

It is not possible here to enter into the evidence upon which this theory is based, inasmuch as it is a physiological question which is only indirectly, although most closely and vitally, connected with the subject of water-supply.

A clear understanding of this theory is, however, necessary for those who would deal with the subject of water-supply from a sanitary or hygienic point of view; for it is no theory, but a stern and established fact, that water may be, and frequently is, the means of propagating zymotic disease.

In the case of two zymotic diseases, and these the most fatal and destructive of the entire class, namely, Asiatic cholera and typhoid fever, it is proved beyond all doubt that water contaminated with drainage which has been infected by patients suffering from these

her fleet and her finances are as yet too weak to justify any fear of rivalry, although sufficiently developed to render her a valuable ally. We have alluded to the interests of England in following up a policy of rational and possible Conservatism in the East rather than a policy of mutual concession, of bribes and of spoliation; a policy which at the start has produced many embarrassments, and which may lead to ulterior complications highly prejudicial to British interests in the East.

We have also shown how Italy is bound by all her precedents to such a Conservative policy, and how unwise it would be on her part to indulge in a policy of adventures which might prove fatal to herself and also to others. Lastly, we have explained why Italy feels at her ease wherever the British standard is hoisted. For what does Italy require in pursuance of her pacific mission? She demands liberty to barter, facility of access, freedom and facility of action; and for these requirements no other flag can offer an equal guarantee in distant and neighbouring seas. Thus public opinion in Italy viewed with indulgence the British conquests around her, and, while objecting to others which present an exclusive and hostile aspect, would, we have no doubt, look favourably on the alliance we have pointed out in spite of the fable of the lion, where one party has all and the other nothing.

Apparently such a policy would meet with the support and sympathy of Germany—a country occupied, like Italy, with its internal organisation, and therefore disinclined in view of her own interests to enter into distant adventures. But whatever may be her future course of policy, Germany cannot now view with indifference any radical changes in favour of other Powers in Oriental regions, and far less would she care to learn that the peace of Europe had been jeopardised without her sanction or cognisance. Like all those who are strong, she can afford to wait. To those who know how to wait, everything comes in due season.

We unhesitatingly assert that just as the alliance conceived and brought about between Germany and Italy has saved the peace of Europe, an alliance between Italy and England would be conducive to the peace of the world.

As far as Italy is concerned, she saw her star rise under the auspices of an alliance with England in support of the integrity of the ancient Orient; an alliance evidently less calculated for Eastern interest than for the progress of European civilisation. We do not doubt that if she proceeds on her course under the same auspices, she will secure the advantages due to her, and justify the position she has assumed among the States of Europe.

F. Nobili Vitelleschi.

diseases, is capable of inducing the same diseases in persons drinking of this infected water.

It is impossible here to detail the experiences which have placed these facts beyond doubt, but I am tempted, in the presence of the danger from cholera with which we are now threatened, to refer briefly to the irresistible evidence afforded by the epidemics of this disease to which the metropolis has been subjected.

The scale on which the propagation of cholera by drinking-water was put to the test was there so vast, and the results of the experiments, which were involuntarily made during these epidemics, so terrible and destructive, as to be peculiarly interesting and instructive in connection with this subject.

London has been visited on four different occasions by epidemics of Asiatic cholera; these visitations occurred in the years 1832, 1849, 1854, and 1866. The mortality in 1832 was undoubtedly great; at that time there was no official registration of the causes of death, but, according to the report of the Privy Council, it appears that the deaths of 5,275 persons in London were referred to cholera. Taking into consideration the population of London at that time, this represents a mortality of 31·4 per 10,000 inhabitants.

In 1849 deaths attributed to cholera in the metropolis amounted to 14,137, or 61·8 per 10,000.

In 1854 there were 10,738 victims, or 42·9 per 10,000; whilst in 1866 cholera was fatal to 5,596 persons, or 18·4 per 10,000 inhabitants.

Now let us examine what was the state of the metropolitan water-supply during these several epidemics. It will be seen that during the period from 1832 to 1866 this water-supply underwent important changes.

In 1832 a considerable part of London was supplied with water abstracted from the Thames and the Lea, the remainder being obtained from shallow wells. At that time the river-waters within the metropolis cannot have been nearly so much polluted as subsequently, owing partly to the smaller population upon their banks, but chiefly to the absence of an efficient system of sewerage in the metropolis. In 1849 the sources of water-supply remained substantially the same, except that the river-water had probably more and more taken the place of the shallow well-water. In the meantime, however, the sewerage system had become fully developed in London. The drainage of nearly the whole population was thus rapidly conveyed into the three rivers from which the water-supply of London was drawn, namely, the Thames, the Lea, and the Ravensbourne.

These rivers thus became proportionately fouled before distribution. *In fact, at this time the water-companies rapidly restored to the inhabitants of London the drainage matters which the sewers*

had discharged. It was in this epidemic that London suffered most severely, the mortality from cholera amounting to nearly 62 per 10,000 inhabitants. On examining this mortality more in detail, we find, upon the evidence of the late Dr. Farr, medical adviser to the Registrar-General, that amongst the population supplied with water taken from the Thames at Kew cholera was fatal to 8 in 10,000, whilst in the district supplied with water taken from the river at Hammersmith it was fatal to 17 in 10,000, and again in the population supplied with water abstracted from the river below Chelsea Hospital it was fatal to 47 in 10,000, whilst the districts drawing their supply still lower down—namely, at Battersea, and between Hungerford and Waterloo Bridges, where the river was still more foul—suffered to the extent of 163 deaths per 10,000 inhabitants.

Before the next visitation in 1854, a small portion of the water abstracted from the Thames within the metropolis had been replaced by a corresponding volume taken from the river above Teddington Lock, and consequently beyond the reach of the London sewage. Corresponding to this improvement in the water-supply, we find a reduction in the mortality from cholera, which in the subsequent epidemic of 1854 was only 43 per 10,000; although in the same epidemic we find that in those districts still supplied with the foul water below Teddington Lock, the mortality was actually greater than in 1849. Thus on the south side of the river the two great competing water-companies are the Lambeth Company on the one hand, and the Southwark and Vauxhall Company on the other. Of these two companies in 1854 the Southwark and Vauxhall still pumped from the Thames at Battersea, whilst the Lambeth had removed their pumping-station to Ditton above Teddington Lock. The houses supplied by these two companies were in the same district, the pipes of the two companies interlacing and sometimes actually running parallel in the same street, so that, excepting as regards their water-supply, the conditions affecting health in the two sets of houses may be safely assumed to have been identical; *but whereas the mortality amongst the population supplied with the comparatively pure water of the Lambeth Company was only* 40 *per* 10,000, *that of the population supplied with the foul water of the Southwark Company was* 130 *per* 10,000 *inhabitants.*

In the last epidemic, which occurred in the year 1866, all the companies drawing from the Thames had fortunately removed their intakes to points above Teddington Lock, and corresponding to this improvement we find that the mortality fell in this epidemic to 18 per 10,000 inhabitants. It is, however, in this epidemic that perhaps the most striking evidence of the propagation of disease through infected drinking-water is to be obtained. In this year, certain parts of the East End of London suffered most severely from cholera.

These parts of London were in the area of one water-company, and what makes the case the more remarkable and conclusive is, that not the whole area of that water-company suffered. The water-company gave two waters, and the high cholera mortality was apparently restricted to those parts of London which received one of these two supplies—so to speak, to half the district of the East London Company. The source from which this company supplied this half of its district was a source peculiarly exposed to contamination from a foul part of the river Lea.

On August 1 of that year, 1866, the Registrar-General gave notice to the East London Company of the danger of distributing this polluted supply, and from this day the intensity of the disease began to abate, and within the month the number of deaths from cholera was less in the East End than in the other parts of London.

It would be possible to produce abundant further evidence as to the propagation of cholera, not to speak of typhoid fever, through the medium of drinking-water.

But, from what has been already said, it will be seen how vitally is the health of a town, especially in times of epidemic disease, connected with its water-supply. Since then this is the case, let us turn to the water-supply of the metropolis as it is at present, and consider whether it is calculated to promote the interests of health.

The water at present supplied to London is drawn from three sources, namely, the river Thames, the river Lea, and, thirdly, from deep wells sunk into the chalk formation.

First, as regards the water drawn from the Thames, this is supplied regularly by five companies, namely, the Chelsea, West Middlesex, Southwark, Grand Junction, and Lambeth Companies, and occasionally also by the East London Company. The intakes of these several companies are all situated within a few miles of each other, above Teddington Lock, and are thus protected from contamination with the metropolitan sewage which is discharged into the river at Barking and Crossness.

But how are these intakes of the several companies situated as regards the sewage which enters the river above Teddington? They manifestly enjoy no such immunity as regards this source of pollution. The sewage of a population estimated at upwards of half a million enters the river above Teddington, and it is Thames water mixed with the sewage of this half-million of human beings that the companies abstract for the consumption of their ratepayers.

It may naturally be asked how such a revolting practice can be justifiable even in the eyes of a board of directors whose interest it is to continue supplying such water. Numerous theories and apologies

have been framed to meet the case, but it is possible here only to deal with one of the more ingenious of these exeuses.

The doctrine known as the self-purification of river water is one of the most remarkable of the theories which have been started to soothe the eonscience of the river-polluter on the one hand, and of the purveyor of polluted river-water on the other.

As its name implies, this doctrine alleges that noxious organie matters discharged into running water are rapidly destroyed in the eourse of a few miles' flow. A doetrine more utterly dogmatie than this it is diffieult to eonceive, inasmueh as it not only does violenee to all previous knowledge eoneerning the properties of organic substanees in general, but is unsupported by any facts or accurate observations. On the eontrary, the late Rivers Pollution Commissioners eonelusively proved that water once polluted by sewage is but very slowly purified, either by violent agitation on a small scale in the laboratory, or by the aëration to whieh it is subjeeted in passing over weirs and falls in a river-bed. Again, reeent research clearly shows the extreme tenaeity of life which is possessed by the low organisms or bacteria whieh are supposed to be allied to those eapable of eommunicating zymotie disease, a tenacity which will certainly not yield to the hardships of a few hours' bath in river-water.

Moreover, that the Thames water reaehes the intakes of the water companies with a but slightly diminished quantity of organie matter, is unanswerably attested by chemical analysis.

Owing to the official surveillanee which for some years past has been kept over the metropolitan water-supply, the appearance of the water as it reaehes the consumer is very different from what it is in the river itself at the intakes of the companies. For no company would now venture to supply water whieh was aetually offensive to the eye.

Of the eighty-four samples of Thames and Lea water that passed through my hands during the past year, nearly all were, as far as eye-judgment is eoneerned, unimpeaehable. But it must not be supposed that this has always been the ease. All of us must be able readily to call to mind oeeasions when the water drawn in London was, in appearance, not so far removed from that of the river-water at Hampton.

Now this amelioration, as far as the appearanee of the water is eoneerned, is effeeted by means of storage and filtration. By providing ample storage capacity, the companies are enabled to avoid drawing from the river when the latter is unusually foul or in high flood; moreover, during storage a large proportion of the matters held in suspension by the running water is deposited. The second process of purification, namely, filtration, consists in allowing the water to percolate through beds of fine sand and gravel. Now when

this operation is carried out efficiently—that is, when the filters are not overtaxed and are frequently cleansed—the water leaves the companies' works perfectly clear, and, when seen in small volume, almost perfectly colourless.

But chemical analysis shows that this process of filtration through sand is very much less effective in dealing with those organic matters which are dissolved in the water than with those which are only held in suspension. Recent research, moreover, shows that filtration through a *far* greater thickness of sand than could be used by any water-company is quite inadequate to remove those minute organisms which are believed to propagate zymotic disease.

It is far from my desire to depreciate these precautionary measures taken by the water-companies, but I wish to point out that they are very distant from affording any absolute safeguard.

That the river-water supplied in London has undergone a marked improvement since the days when the Thames was tapped at Kew, Chelsea, Battersea, and Hungerford, is undeniable and palpable to all; but what I wish to insist upon is, that this improvement is *in degree and not in kind.*

The Thames at Hampton is a river polluted with sewage just as is the Thames at Battersea, the only difference being that at Hampton it is fouled with the sewage of about half a million persons, while at Battersea it is liable to pollution by more than six times that number.

In order to effect an improvement in kind as well as in degree, it will be necessary to altogether abandon the river Thames as a source of supply. It has not been found difficult to suggest substitutes for Thames water; schemes have been proposed in which the sources of the Severn, the upland surface waters of Derbyshire, and even the waters of the Cumberland lakes, were to be called into requisition.

These proposals, some of which are not a little startling, were all made at a time when it was not known, as it now is, that the valley of the Thames abounds in water of the very best quality. I refer to the vast quantity of water obtainable from the chalk and oolite beds.

Now it is to this source of pure water that the only London water-company which has entirely abandoned the polluted rivers flowing through the metropolis has turned. Already, before 1866, and since, the Kent Company has continuously supplied water derived from deep wells sunk into the chalk.

Chemical analysis, and a consideration of the source of this deep-well water, are alike convincing as to its immeasurable superiority over Thames water. Over a space of many years this water has remained of almost uniform purity, and this without being subjected to any artificial filtration at the hands of the company.

For this water has undergone an inimitable process of natural filtration through vast thicknesses of porous strata, thus removing nearly all matters in suspension, and reducing almost to zero the organic matters in solution. This water, when seen in large volume, has a fine blue colour, which is not surpassed by the waters of the purest lake in Switzerland.

Again, this water possesses a great advantage in maintaining an almost constant temperature throughout the year, whilst river-water is subject to great extremes of heat and cold according to the season.

The quantity of this water available in the valley of the Thames must be very great indeed; thus, in a small enclosure at Deptford, there are three wells 250 feet deep, of which one yields 1½ million, and the other two each 4½ million gallons daily, and the engineer of the Kent Company states that this quantity could be greatly increased if required.

There is only one point in which this deep-well water is inferior to the river water, and that is in respect of hardness. This hardness, although not in any way prejudicial to the wholesomeness of the water, is disadvantageous for laundry, steam, and most other manufacturing purposes; it may, however, be almost entirely removed, even on the large scale, by a process of softening to which I shall presently refer.

Thus, without troubling the Derbyshire hills, or defacing the Lake-district with embankments and aqueducts, it is possible to obtain in and around London a plentiful and wholesome supply of water. It was in the following terms that the late Rivers Pollution Commissioners expressed themselves concerning this matter:—

> The supply of such water, either softened or unsoftened, to the metropolis generally, would be a priceless boon, and would at once confer upon it absolute immunity from epidemics of cholera. We are decidedly of opinion that the metropolitan companies should receive from your Majesty's Government sanction for increase of capital, only on condition that such capital shall be expended on works necessary for the supply of this palatable and perfectly wholesome beverage.

The improvements and alterations in water-supply hitherto referred to can only be realised by parliamentary measures, and are wholly beyond the control of private individuals. I shall now turn my attention to matters connected with water-supply which do lie within the scope of individual action and enterprise.

First, as regards the softening of water. The so-called 'hardness' of water is occasioned by the presence of salts of lime and magnesia dissolved in the water. These salts decompose soap with formation of insoluble curds, and it is not until the whole of the lime and magnesia has been precipitated as curds that a lather is obtainable with soap.

Thus all water, before it is available for cleansing with soap, must be softened, that is, deprived of its lime and magnesia salts in solution. Under ordinary circumstances this softening is effected by means of the soap itself, which refuses to lather until the whole of the lime and magnesia in the water has been removed as curds.

Now soap is a very costly article, and forms, as is well known, a formidable item in household expenditure. Since far the greater proportion of this soap is not used in cleansing at all, but simply in preparing the water for this purpose, it follows that a very great household economy would be the result of employing some less costly article than soap for thus preparing the water for washing.

Now such an article exists in the shape of lime itself, which, when added in the right proportion, effects this preliminary softening of the water at a very much cheaper rate.

The process of softening water by lime is known as Clark's process, and the following numbers show what an exceedingly valuable process this is. Thus, to soften a quantity of water which requires 1 cwt. of lime, the cost by Clark's process would be 8*d*., whilst if the same water were softened in the ordinary way with common yellow soap, to say nothing of the more delicate preparations in general use for toilet purposes, the cost would amount to 47*l*. 1*s*. 8*d*.

Clark's process is, however, only applicable to water which owes its hardness, entirely or chiefly, to the carbonates of lime and magnesia—so-called *temporary hardness*; whilst water which is hardened by sulphate of lime or sulphate of magnesia—the so-called *permanent hardness*—cannot be thus softened. The water supplied in London, both from the rivers and from the deep wells in the chalk, is particularly well adapted for softening by this process.

There is at present but one company in the London district that supplies soft water well fitted for washing, and this company—the Colne Valley Company—furnishes this soft supply by treating with Clark's process the hard water obtained from the chalk. Although this process is somewhat too cumbrous to be conveniently applied in private houses, yet in hospitals, workhouses, and large establishments it may be adopted with great advantage.

By means of Clark's process a considerable reduction in the amount of organic matter in the river water is also effected, this being mechanically carried down by the precipitated chalk.

The second improvement in water which lies within the scope of private individuals is that of *domestic filtration*.

The subject of domestic filtration is one which, in a town with a water-supply like that of London, possesses peculiar interest, and is of no little importance. Most people imagine that by once going to the expense of a filter they have secured for themselves a safeguard which will endure throughout all time without further trouble. No

mistake could be greater, for without preserving constant watchfulness, and bestowing great care upon domestic filtration, it is probable that the process will not only entirely fail to purify the water, but will actually render it more impure than before. For the accumulation of putrescent organic matter upon and within the filtering material furnishes a favourable nest for the development of minute worms and other disgusting organisms, which not unfrequently pervade the filtered water; whilst the proportion of organic matter in the effluent water is often considerably greater than that present before filtration.

Of the substances in general use for the household filtration of water, spongy iron and animal charcoal take the first place. Both of these substances possess the property of removing a very large proportion of the organic matter present in water. They both, in the first instance, possess this purifying power to about an equal extent; but whereas the animal charcoal very soon loses its power, the spongy iron retains its efficacy unimpaired for a much longer time. Indeed, in spongy iron we possess the most valuable of all known materials for filtration, inasmuch as, besides removing such a large proportion of organic matter from water, it has been found to be absolutely fatal to bacterial life, and thus acts as an invaluable safeguard against the propagation of disease through drinking-water.

It is satisfactory to learn that in countries where the results of scientific research more rapidly receive practical application than is unfortunately the case amongst us, spongy iron is actually being employed on the large scale for filtration where only a very impure source of water-supply is procurable. I refer to the recent introduction of spongy-iron filter-beds at the Antwerp waterworks. It would be very desirable that such filter-beds should be adopted by the London water companies until they shall abandon the present impure source of supply.

Animal charcoal, on the other hand, far from being fatal to the lower forms of life, is highly favourable to their development and growth; in fact, in the water drawn from a charcoal filter which has not been renewed sufficiently often, myriads of minute worms may frequently be found.

Thus spongy iron enables those who can afford the expense to obtain pure drinking-water even from an impure source; but this should not deter those interested in the public health from using their influence to obtain a water-supply which requires no domestic filtration and shall be equally bright and healthful for both rich and poor.

Many towns in Great Britain have abandoned an impure water-supply. Glasgow drinks the waters of Loch Katrine; Manchester is supplied by the unpolluted water collected on the high ground of

Derbyshire and Cheshire, and a supplementary supply is now being brought, under protest of the Kyrle Society, it is true, from Thirlmere in Cumberland.

How long will it be before London insists upon having the equally wholesome water which nature has brought far nearer our doors than Loch Katrine is to Glasgow or Thirlmere to Manchester? We will hope that it may not require another epidemic of cholera to teach the inhabitants of this city that, in the interests of temperance and health, the rivers Thames and Lea must be wholly abandoned as sources of water-supply.

PERCY FARADAY FRANKLAND.

'THE SPOLIATION OF INDIA.'

Erratum.- In the article with the above title published last month, on page 7 the figures of Mr. John Bright's Parliamentary return giving the number of Europeans in the Indian Military Department, each drawing more than 100*l.* a year from the Indian Treasury, and the total amounts drawn by them, were, by an unfortunate error, very much understated, the argument being of course correspondently weakened. The total amount thus drawn by military Europeans is 5,958,067*l.*, instead of 4,736,000*l.* The total number of persons receiving it is 12,930 instead of 8,103. Of these the absentees number no less than 6,069, or not far from 50 per cent. of the whole; and the amount received annually from the Indian Treasury by these absentees should have been given as 2,170,184*l.* instead of 815,736*l.*

J. Seymour Keay.